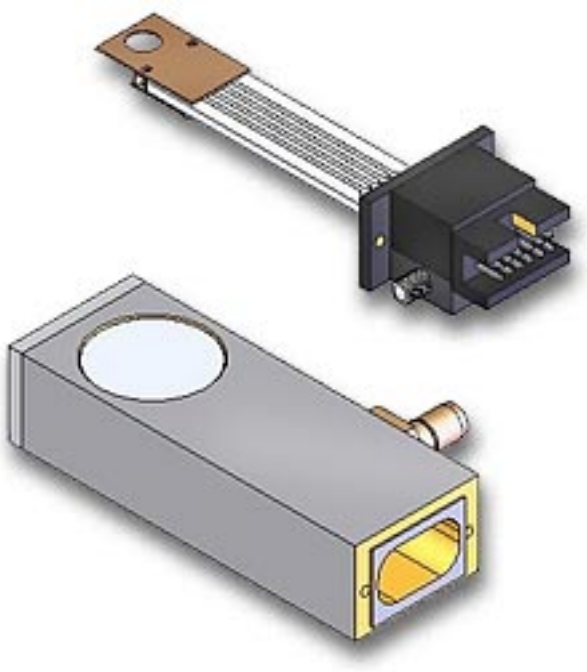

Micro Miniature Refrigerators are small, cryogenic refrigerators that derive their cooling power from the Joule-Thomson expansion of a high-pressure gas. This effect is amplified by using the cooled gas to pre-cool incoming gas in a counter-current heat exchanger. Temperatures down to 70 K can be achieved in devices a little larger than a matchbox in size.

MMR's Optical Transmission System is designed for optical transmission studies of materials over a wide range of temperatures. A gold-plated copper stage for holding the sample is attached to the cold pad of the micro miniature refrigerator. The stage has a 6 mm hole in it that is aligned with the two windows of the vacuum enclosure.

The sample is mounted on the copper tab attached to the end of the refrigerator using the 6mm working distance to allow for the focal depth of the IR microscope's objective. Once the refrigerator is sealed inside the vacuum shroud, the unit is placed in a custom aluminum holder which then fits in the microscope x-y stage.

Features

- Operating Temperature: 70 K to 730 K (or 70 K to 580 K for our second one)
- Temperature Stability: ±0.05 K with K-20 Programmable Controller
- Temperature Response: 1 K/sec

- Cooling Capacity: 250 mW at 85 K with nitrogen; 500 mW with Ar at 90 K
- Cold pad size: 14 mm x 10 mm
- Vacuum shroud windows: KBr or KRS-5
- Working Distance Above Cold Stage inside vacuum shroud: 6 mm.
- Transmission Aperture: Approximately 7 mm diameter
- Weight of Vacuum Chamber: 114 g (4 oz)
- Will just fit on 1.4.3 or 1.4.4 microscope stage with the 15x objective using our customized stage insert.

For cooling with the Joule-Thompson effect, high pressure high purity Nitrogen or Argon gas is used. Please talk to us before you arrive to ensure a gas tank is available for your beamtime.

The MMR microcoolers can also be used for sample heating above room temperature without the use of vacuum shroud (if only moderate heating is required), and without the gas tank. The temperature controller is capable of maintaining an accurate temperature in heating mode up to 580 or 730 K.

Operation

To use these refrigerators for the first time, please have Mike help walk you through it once. This section will give you some general procedures to follow, but please do not try to operate the refrigerators with only this brief overview as they are delicate.

Once you have a sample mounted on the copper sample clip, insert the refrigerator into the vacuum chamber with the rubber interface gasket in place. Tighten the two small screws to get a good seal on the gasket. Place the unit on the microscope stage using the specially made aluminum holder. Attach the high-pressure gas lines from the gas cylinder (high purity Nitrogen or Argon) to the long tubular filter, then to the refrigerator inlet. Attach the small rubber hose to the gas outlet and to the flowmeter. Connect the temperature controller electronics ribbon cable to the refrigerator making sure the tab is on the correct side - the connector should slide on easily. Finally attach the vacuum hosing to the pump out port on the vacuum chamber.

Now that the system is fully assembled, follow the steps below to get your sample to the proper temperature:

1. Run about 500-psi of Nitrogen (or Argon) through the system for about 30 seconds to purge it of any moisture that may have collected during nonuse.

2. Turn on the vacuum pump and wait for the pressure to reach ~10 millitorr.

3. For cooling: turn up the high-pressure nitrogen regulator to 1800-psi MAXIMUM. Make sure the flowmeter shows that gas is flowing - a typical reading is 3.5. The sample should now begin to cool. For heating: skip this step.

4. Turn on the K-20 temperature controller. Check that the temperature reading is reasonable, then set your desired temperature set-point (see below for how to operate the K-20).

5. Once the temperature has stabilized, conduct your experiment.

6. After the experiment is finished, turn off the high-pressure gas. Allow the refrigerator return to near room temperature, then turn off the vacuum. You can now power down the K-20, disconnect the various connections, and remove the MMR system from the microscope and return everything to where they came from.

Operation of the K-20 Temperature Controller

All functions of the K-20 controller can be accessed via the blue C-2000 keypad and display. A summary of the most common commands for operating the unit is shown below. More details can be found in the MMR manuals, but most users can get by with just the following.

Command	How to remember	What you get	Typical response
TE		TE	mperature Display
	WK		W hat
SK ###.##		S	et K
PO		PO	wer Display
MOx		MO	nitor every x seconds Diplays

OK AUTO>

274.21 K

00.000W AUTO>

repeats ...	